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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/007,630	11/09/2001	Ming Cai	06618-736001/CIT-3345	9976

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EXAMINER
CALEY, MICHAEL H

ART UNIT	PAPER NUMBER
2882	

DATE MAILED: 03/13/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/007,630	CAI ET AL.	
	Examiner	Art Unit	
	Michael H. Caley	2882	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on _____ .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-29* is/are pending in the application.

4a) Of the above claim(s) *21-24* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-7,9,10,13-16,18,19 and 24-29* is/are rejected.

7)☒ Claim(s) *1,8,11,12,17 and 20* is/are objected to.

8)☒ Claim(s) *21-24* are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☒ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) *4 and 5* .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

Election/Restrictions

Restriction to one of the following inventions is required under 35 U.S.C. 121:

I. Claims 1-20 and 24-29, drawn to a tapered waveguide, classified in class 385, subclass 43.

II. Claim 21, drawn to a method of constructing a fiber, classified in class 65, subclass 407.

III. Claims 22 and 23, drawn to a method of using a coupler, classified in class 372, subclass 92.

The inventions are distinct, each from the other because of the following reasons:

Inventions I and II are related as process of making and product made. The inventions are distinct if either or both of the following can be shown: (1) that the process as claimed can be used to make other and materially different product or (2) that the product as claimed can be made by another and materially different process (MPEP § 806.05(f)). In the instant case the tapered waveguide as claimed may be formed as a planar waveguide.

Inventions I and III are related as product and process of use. The inventions can be shown to be distinct if either or both of the following can be shown: (1) the process for using the product as claimed can be practiced with another materially different product or (2) the product as claimed can be used in a materially different process of using that product (MPEP § 806.05(h)). In the instant case the tapered waveguide coupler as claimed may be used as a light source coupler. Takahashi (U.S. Patent No. 5,530,781) discloses the use of a dual tapered

fiber with a reflection layer to maintain optical power propagating in the clad within the optical fiber (Column 5 lines 3-7).

During a telephone conversation with Bing Ai on 3/6/03 a provisional election was made without traverse to prosecute the invention of Group I, claims 1-20 and 24-29. Affirmation of this election must be made by applicant in replying to this Office action. Claims 21-23 are withdrawn from further consideration by the examiner, 37 CFR 1.142(b), as being drawn to a non-elected invention.

Applicant is reminded that upon the cancellation of claims to a non-elected invention, the inventorship must be amended in compliance with 37 CFR 1.48(b) if one or more of the currently named inventors is no longer an inventor of at least one claim remaining in the application. Any amendment of inventorship must be accompanied by a request under 37 CFR 1.48(b) and by the fee required under 37 CFR 1.17(i).

Claim Objections

Claim 1 is objected to because of the following informalities: lack of antecedent basis and unclear language. As written, "said one end" of line 13 references a part of the second fiber at the point of the splice and "said another opposing end" of line 14 references part of the first fiber at the point of the splice. The Examiner suggests the following revision: "said another opposing end" of line 14 should read --said another end--; and "decreases" should read as --increases--.

Appropriate correction is required.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 13, 14, 24, and 25 are rejected under 35 U.S.C. 102(b) as being anticipated by Knight et al. ("Phase-matched excitation of whispering-gallery-mode resonances by a fiber taper", Optics Letters, vol. 22, pp. 1129-1131, 1997).

Regarding claim 13, Knight discloses:

an optical fiber coupler having a tapered fiber section (Figure 2A) formed of a fiber cladding material to form an optical waveguide based on interfacing between the fiber cladding material and air (Page 1129), a first single-mode fiber (Page 1129, abstract) for light at a first wavelength connected to a first side of said tapered fiber section (Figure 2A), and a second single mode fiber for light at a second wavelength connected to a second side of the tapered fiber section (Figure 2A),

wherein said tapered fiber section has a structure to support at least one waveguide mode at said first wavelength and one waveguide mode at said second wavelength (Page 1129),

wherein first and second wavelengths may or may not be the same.

Regarding claim 14, Knight discloses the first and second single-mode fibers as connected to the tapered fiber section under an optical adiabatic transformation (Page 1129).

Regarding claim 24, Knight discloses a coupler having:

a tapered waveguide section to guide optical energy in at least one mode at a first wavelength and one mode at a second wavelength and to expose an evanescent field of said guided optical energy outside the tapered waveguide section (Page 1129);

a first waveguide section to guide optical energy in at least one mode at a first wavelength connected to a first side of the tapered waveguide section to allow for conversion of optical energy between the one mode at the fist wavelength in the tapered waveguide section and the first single mode (Page 1129); and

a second waveguide section supporting a second single mode at the second wavelength connected to a second side of the tapered waveguide section to allow for conversion of the optical energy between the one mode at the second wavelength in the tapered waveguide section and the second single mode (Page 1129).

Regarding claim 25, Knight discloses the waveguide section as formed of a fiber (Page 1129).

Claims 24 and 27 are rejected under 35 U.S.C. 102(b) as being anticipated by Takahashi (U.S. Patent No. 5,530,781).

Regarding claim 24, Takahashi discloses:

a tapered waveguide section to guide optical energy in at least one mode at a first wavelength and one mode at a second wavelength and to expose an evanescent field of said guided optical energy outside the tapered waveguide section (Figure 1 elements 22 and 23; Column 7 lines 16-31);

a first waveguide section to guide optical energy in at least one mode at a first wavelength connected to a first side of the tapered waveguide section to allow for

conversion of optical energy between the one mode at the fist wavelength in the tapered waveguide section and the first single mode (Figure 1 element 20); and

a second waveguide section supporting a second single mode at the second wavelength connected to a second side of the tapered waveguide section to allow for conversion of the optical energy between the one mode at the second wavelength in the tapered waveguide section and the second single mode (Figure 1 element 19);

wherein the first wavelength and the second wavelength may be the same.

Regarding claim 27, Takahashi discloses the optical element as located to evanescently couple light at the first wavelength from the tapered waveguide section and to evanescently couple light at the second wavelength into the tapered fiber section (Figure 1 element 26; Column 7 lines 16-31).

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 1-3 and 9 are rejected under 35 U.S.C. 103(a) as being unpatentable over Takahashi in view of Kapron et al. (U.S. Patent No. 3,779,628 "Kapron").

Regarding claim 1, Takahashi discloses:

a first fiber having a first untapered fiber section (Figure 1 element 19) which is a single-mode fiber (Column 4 lines 62-65) for light at a first wavelength and a first tapered fiber section

having a fiber diameter gradually reducing from said one end to another opposing end (Figure 1 element 23);

a second fiber having a second tapered fiber section, wherein a fiber diameter of said second tapered fiber section gradually decreases from one end to another end, and

wherein said second tapered fiber section is a single-mode fiber (Column 4 lines 62-65) for light at a second wavelength and has a maximum core diameter greater than the maximum diameter of a fiber core of the first tapered fiber section (Figure 1).

Takahashi fails to disclose a second untapered fiber section and also fails to disclose the second untapered fiber as having a core diameter greater than a diameter of a fiber core of the first untapered fiber section. Kapron, however, teaches an untapered fiber section connected to a tapered fiber section in an optical waveguide light source coupler (Figure 3; Column 6 lines 1-4).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to have constructed the coupler to have a second untapered fiber section having a diameter equal to the maximum diameter of the corresponding tapered section adjacent to the light source. Such a modification to Takahashi's fiber light coupling interface would have been an engineering expediency to improve the positional relationship between the light source and the fiber. Depending on the light source used, one of ordinary skill in the art would have been motivated to add an enlarged, untapered section to the incident surface to benefit from advantages due to the changed incidence angle and refractive index as are old and well known in the art. As suggested by Kapron, such a design may be achieved by retaining a portion of a larger diameter fiber from which the optical fiber is drawn. This design may be achieved by

allowing a portion of the enlarged section in Takahashi's device (Figure 2A element 20) to be retained after drawing the fiber as shown in Figure 2C.

Regarding claim 2, it would have been inherent that each structural variation from a respective untapered fiber section to a respective tapered fiber section satisfy an optical adiabatic transformation condition to transform optical energy in a single mode in either of said first and said second untapered fiber sections in said first and said second wavelengths, respectively, into optical energy in a mode in said first and said second tapered fiber sections. Such a design consideration would have been necessary to propagate light through the waveguide at a high efficiency. (Column 3 lines 44-51).

Regarding claim 3, Takahashi discloses the coupler as having an optical element (Figure 1 element 26) located in an evanescent field of guided optical energy in one of the first and second tapered fiber sections to evanescently exchange optical energy at the first wavelength with the first fiber and exchange optical energy at the second wavelength with the second fiber (Column 7 lines 16-31).

Regarding claim 9, Takahashi discloses the coupler as located to evanescently receive light at the first wavelength received from the second untapered fiber section and to evanescently couple light at the second wavelength through one of the first and second tapered fiber sections into the first untapered fiber section (Column 7 lines 16-31). Therefore, the coupler is inherently located to evanescently couple light in a reversed manner as proposed.

Claims 1, 3-7, 9, and 10 are rejected under 35 U.S.C. 103(a) as being unpatentable over Cai et al. ("Fiber-couplded microsphere laser", Optics Letters, Vol. 25, No.19, pp 1430-1432, October 1, 2000) in view of Kapron.

Regarding claim 1, Cai discloses a coupler having:

a first fiber having a first untapered fiber section which is a single-mode fiber for light at a first wavelength and a first tapered fiber section having a fiber diameter gradually reducing from said one end to another opposing end (Page 1430; Figure 1A);

a second fiber having a second untapered fiber section and a second tapered fiber section which has one end being spliced to the opposing end of the first tapered fiber section and another end conforming to and connected to the second untapered fiber section, wherein a fiber diameter of said second tapered fiber section gradually decreases from one end to another end (Page 1430; Figure 1A), and

wherein said second tapered fiber section is a single-mode fiber (Column 4 lines 62-65) for light at a second wavelength.

Cai fails to disclose the second untapered section as having a core diameter greater than a diameter of a fiber core of the first untapered section. Kapron, however, teaches an enlarged tapered core adjacent to an untapered core for efficiently coupling light from a light source to a fiber (Figure 3; Column 6 lines 1-4).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to have adjusted a taper on the side of the coupler proximal to the light source in Cai's design to create an enlarged incident surface for the light source. Such a design modification would have been motivated by a desire to increase the coupling efficiency between the light

source and waveguide. An increased coupling efficiency would have been advantageous in such a laser pumping application to reduce the energy needed to power the laser.

Regarding claim 3, Cai discloses the coupler as having an optical element located in an evanescent field of guided optical energy in one of the first and second tapered fiber sections to evanescently exchange optical energy at the first wavelength with the first fiber and exchange optical energy at the second wavelength with the second fiber (Page 1430; Figure 1).

Regarding claim 4, Cai discloses the optical element as including a micro cavity that supports at least one whispering gallery mode at said first wavelength and one whispering gallery at said second wavelength (Page 1430).

Regarding claim 5, Cai discloses the micro cavity as in direct contact with a respective tapered fiber section (Page 1431).

Regarding claim 6, the micro cavity is inherently spaced from a tapered fiber section of one of the first and second fibers. Due to the geometry of the sphere and the tapers, it is not possible for the sphere to be in contact with all parts of both tapers.

Regarding claim 7, Cai discloses the micro cavity as a sphere.

Regarding claim 9, Cai discloses the coupler as located to evanescently receive light at the first wavelength received from the second untapered fiber section and to evanescently couple light at the second wavelength through one of the first and second tapered fiber sections into the first untapered fiber section (Page 1430). Therefore, the coupler is inherently located to evanescently couple light in a reversed manner as proposed.

Regarding claim 10, Cai discloses the optical element as including an optical cavity (Page 1430).

Claims 13-16, 18, and 19 are rejected under 35 U.S.C. 103(a) as being unpatentable over Knight in view of Cai.

Regarding claim 13, Cai discloses an optical fiber coupler having:

a first fiber for light at a first wavelength connected to a first side of said tapered fiber section, and a second fiber for light at a second wavelength connected to a second side of the tapered fiber section (Figure 1A),

wherein said tapered fiber section has a structure to support at least one waveguide mode at said first wavelength and one waveguide mode at said second wavelength (Page 1129).

Cai fails to disclose the optical fiber coupler as having the tapered fiber section formed of a fiber cladding material to form an optical waveguide based on interfacing between the fiber cladding material and air. Knight, however, teaches a highly efficient coupling technique between a single mode fiber taper and a sphere resonator in which single mode fiber is tapered to form a waveguide based on interfacing between the silica cladding portion and air.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to have modified Cai's tapered coupling fiber as taught by Knight. By forming a waveguide based on interfacing between the fiber cladding material and air, a maximum amount of the optical energy may be coupled to the optical element, as taught by Knight. Increasing the amount of light coupled to the optical element would have been motivated by a desire to maximize the coupling efficiency from the pump input to the laser output. Such a design would have been advantageous to conserve power in operating the laser.

Regarding claim 14, Cai fails to disclose the first and second fibers as connected to the tapered fiber section under an optical adiabatic transformation. Knight, however, teaches the fiber taper as performed in an adiabatic transformation in order to couple light most efficiently (Page 1129).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to have created an adiabatic transformation between the fibers and tapered fiber sections. Such a design consideration would have been motivated by a desire to minimize loss through the taper, effectively increasing the coupling efficiency from the light source to the optical element. Creating an adiabatic transformation would have been advantageous to conserve power in operating the laser.

Regarding claim 15, Cai discloses a micro cavity that supports at least one whispering gallery mode at the first wavelength and second wavelength, absorbing light at the first wavelength to produce light at the second wavelength, the micro cavity located relative to the tapered fiber section to evanescently receive light at the first wavelength from the tapered fiber section and to evanescently couple the light at the second wavelength into the tapered fiber section.

Regarding claim 16, Cai discloses the micro cavity as in direct contact with a respective tapered fiber section (Page 1431).

Regarding claim 18, Cai discloses the micro cavity as a dielectric material doped with rare-earth ions (Page 1430, abstract).

Regarding claim 19, Cai discloses the micro cavity as a sphere (Page 1430).

Claim 26 is rejected under 35 U.S.C. 103(a) as being unpatentable over Knight in view of Ho (U.S. Patent No. 5,926,496).

Knight fails to disclose the waveguide sections as formed of a planar waveguide on a substrate. Ho, however, teaches a microcavity resonator device formed of a planar waveguide on a substrate.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to have formed the waveguide sections of the coupler disclosed by Knight from a planar waveguide on a substrate. As taught by Ho, such resonators have applications as switches, intensity modulators, filters, and WDM multiplexors (Column 2 lines 43-47). One of ordinary skill in the art would have been motivated to construct Knight's device of a planar waveguide on a substrate in order to benefit from advantages as are old and well known in the art. Such advantages include precision in forming the waveguide using advanced etching techniques and incorporating such devices in an integrated optical circuit in a confined space. Forming the waveguide on a planar substrate would allow for the device to be constructed precisely in a confined space and to benefit from a maximum coupling efficiency due to the high precision construction.

Claims 27-29 are rejected under 35 U.S.C. 103(a) as being unpatentable over Knight in view of Cai.

Knight discloses an optical element located to evanescently couple light at the first wavelength from the tapered section. Knight fails to disclose the optical element as located to evanescently couple light at the second wavelength into the tapered fiber section. Cai, however,

teaches an optical element located to evanescently couple the light at the first wavelength from the tapered waveguide and to evanescently couple light at the second wavelength into the tapered fiber section in a microsphere laser application (Page 1430).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to have utilized the high efficiency coupling between a microsphere and a fiber in realizing a fiber-coupled microsphere laser as taught by Cai. One would have been motivated to locate the microsphere as taught by Cai in order to evanescently couple a laser wavelength from the optical device to the fiber. Such a modification would have been advantageous to allow for the realization of an efficiently coupled laser using the apparatus as disclosed by Knight and the teachings from Cai.

Regarding claim 28, Knight discloses the optical element as including an optical cavity (Page 1129).

Regarding claim 29, Knight discloses the optical cavity as a whispering-gallery-mode cavity.

Allowable Subject Matter

Claims 8, 11, 12, 17, and 20 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Conclusion

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Little et al. "Analytical theory of coupling from tapered fibers and half-blocks into microsphere resonators", Journal of Lightwave Technology, vol. 17, no. 4, pp. 704-715, April, 1999.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Michael H. Caley whose telephone number is (703) 305-7913. The examiner can normally be reached on M-F 8:30 a.m. - 5:00 p.m..

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Robert Kim can be reached on (703) 305-3492. The fax phone numbers for the organization where this application or proceeding is assigned are (703) 308-7722 for regular communications and (703) 308-7724 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0956.

mhc
March 7, 2003

SUPERVISORY PATENT EXAMINER
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